MAIN PROPULSION ENGINE SYSTEM INTEGRATED WITH SECONDARY POWER UNIT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a power plant suitable for aircraft and, more particularly, to a new power plant arrangement wherein a secondary power unit is integrated within a main propulsion system of an aircraft or the like.

2. Description of the Prior Art

It is well known to mount an auxiliary power unit in the tailcone section of an aircraft to supply pressurized air for environmental control systems or main engine starting, and shaft horsepower to drive accessories such as an electric generator while the aircraft is on the ground and the main propulsion engines thereof are shutdown. In flight, the auxiliary power unit is typically shut off. However, auxiliary power units are occasionally used in flight, for instance, in the event of a main engine generator malfunction.

Such a tail mounted auxiliary power unit is commonly considered to be a low-utilization device that adds weight and complexity to the airplane while providing little operational benefits during most flight conditions.

SUMMARY OF THE INVENTION

It is therefore an aim of the present invention to simplify the installation of a secondary power unit by integrating it with a main engine into a single power plant.

It is also an aim of the present invention to provide installation and certification cost savings to airframers by eliminating the tailcone auxiliary power unit installation.

It is a further aim of the present invention to improve the performances of an aircraft secondary power unit during flight conditions.

Therefore, in accordance with the present invention, there is provided a power plant for a vehicle, comprising a nacelle cowl and a primary gas turbine engine mounted within said nacelle cowl and forming therewith a main vehicle propulsion system, and a secondary power system integrated to said main vehicle propulsion system for providing auxiliary power to the vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

Having thus generally described the nature of the invention, reference will now be made to the accompanying drawings, showing by way of illustration a preferred embodiment thereof, and in which:

Fig. 1 is a schematic side view of an aircraft power plant wherein an auxiliary power unit is mounted in a core compartment of a main propulsion engine in accordance with a first embodiment of the present invention;

Figs. 2 to 5 are schematic side views illustrating different possible inlet and exhaust configurations for a main engine core mounted auxiliary power unit; and

Fig. 6 is a schematic side view of an aircraft power plant wherein an auxiliary power unit is mounted to the aft center body of the main propulsion engine in accordance with a further embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As will be seen hereinafter, the present invention is generally directed to a new aircraft power plant, whereby a pair of secondary power units can be integrated into respective main aircraft propulsion engines in replacement of a conventional auxiliary power unit, which is typically separately mounted to the airframe of the aircraft at the tail section thereof.

Fig. 1 illustrates a first embodiment of such a new aircraft power plant 10. The power plant 10 comprises a nacelle cowl 12 having an inlet end 11 and an exhaust nozzle end 13, and a main propulsion engine 14 housed within the nacelle cowl 12. An inner core cowl 16 is concentrically mounted within the

nacelle cowl 12 about the main propulsion engine 14. The inner core cowl 16 and the nacelle cowl 12 define therebetween an annular by-pass passage 18.

The main propulsion engine 14 has a casing assembly 20 defining an annular core flow passage 22. The casing assembly 20 defines with the inner core cowl 16 an engine core compartment 23 in which various components can be received.

The main propulsion engine 14 consists of a gas turbine engine having a compressor section 24 which typically includes a fan (not shown) and a high pressure compressor (not shown), a combustion section 26 and a turbine section 28, as is well known in the art. In operation, the gas turbine engine inducts ambient air via the inlet end 11. A portion of the air is diverted into the by-pass passage 18 and discharged at the exhaust nozzle 13. Before being directed into the by-pass passage 18, the air is compressed in the compressor section 24 of the gas turbine engine. The other portion of the air, which is drawn into the nacelle cowl 12, is caused to flow through the core flow passage 22. The air flowing through the core flow passage 22 is compressed in the compressor section 24 and is then directed to the combustion section 26 where it is mixed with fuel and ignited. The combustion gases from the combustion section 26 are then delivered to the turbine section 28 for driving the compressors (not shown) of the compressor section 24 and the

engine accessories (not shown). The expanded gases from the turbine section 28 are discharged through the exhaust nozzle end 13 with the air emanating from the bypass passage 18.

As seen in Fig. 1, a secondary power unit 30 is mounted within the engine core compartment 23 instead of being mounted to the aircraft tail section as is conventionally done. According to the illustrated embodiment, the secondary power unit 30 consists of an auxiliary power unit of the type used for providing pneumatic air to loads, such as the aircraft passenger cabin, electrical power to the aircraft, and starting the main propulsion engine 14 pneumatically, while the aircraft remains stationary on the ground. However, it is understood that the secondary power unit 30 could consist of various types of multifunction power unit having a gas turbine engine section. For instance, the secondary power unit could consist of an auxiliary power unit having an environmental control system (ECS), such as an air cycle machine. The secondary power unit 30 could also consist of a multifunction power unit integrating an auxiliary power unit (APU), an emergency power unit (EPU), an environmental control system (ECS) and an engine start system (ESS).

The secondary power unit 30 includes a secondary gas turbine engine 31 having a compressor section 32, a combustion section 34 and a turbine section 36. As seen in Fig. 1, a radial

inlet plenum 38 can be provided for allowing air to be drawn from the by-pass passage 18 directly into the gas turbine engine 31. The radial inlet plenum 38 could be provided in the form of a ring member defining a number of air passages extending radially through the engine core compartment 23 to convey air from the by-pass passage 18 to the secondary gas turbine engine 31. The secondary gas turbine engine 31 includes an axial exhaust outlet 40 for directing the expanded gases from the gas turbine section 36 back into the by-pass passage 18.

During ground operation, the inlet air is drawn in through the stationary fan of the primary gas turbine engine and the exhaust nozzle 13, then through the by-pass passage 18 and finally into the secondary gas turbine engine 31 before being discharged back into a aft portion of the by-pass passage 18. In flight, the secondary gas turbine engine inlet flow is boosted by the main propulsion engine fan, as it is compressed thereby before entering into the secondary gas turbine engines 31. This provides for a better secondary gas turbine engine fuel burn when operated at altitude. Aircraft pneumatic and electric power demand is typically provided on the ground by the secondary power unit 30 and by the main engine 14 during flight conditions.

A closure member (not shown) displaceable between closed and open positions can be provided for selectively preventing

air from being drawn into the secondary gas turbine engine 31, while the main engine 14 is being operated. However, due to the inlet boost from the main engine fan, the performances of the secondary power unit 30 are improved as compared to a traditional tail mounted auxiliary power unit and, thus, the secondary power unit 30 could be operated at all time, thereby replacing the engine bleed requirement and eliminating the need for a closure member.

By integrating the secondary power unit 30 to the power plant 10 and, thus, eliminating the tailcone auxiliary power unit installation, significant installation and certification cost savings can be achieved for the airframers. This is also advantageous in that it eliminates the need for an aircraft fire zone and APU containment issues on tail plane, increases the cargo space, reduces pneumatic/hydraulic/ and fuel lines, and also allows for structural cost and weight savings.

The positioning of the secondary power unit 30 into the nacelle cowl 12 also provides for better main engine cold start capabilities due to the secondary power unit 30 preheating effect of the main engine core compartment 23. Indeed, while being operated, the secondary power unit 30 will generate heat that will contribute to warm up the various components of the main engine 14.

The re-light characteristics of the secondary power unit 30 will also be improved in flight due to the inlet boost, the ram air, and the pre-heating thereof by the heat generated by the main engine 14.

In a wing-mounted application, the integration of the secondary power unit 30 with the main propulsion engine 14 into a single power plant will eliminate the need for costly pneumatic piping.

Figs. 2 to 5 illustrate various possible inlet and outlet configurations for the secondary gas turbine engine 31.

As shown in Fig. 2, an axial inlet 42 could be defined in the engine core compartment 23 for directing air from the by-pass passage 18 directly into the secondary gas turbine engine 31.

Alternatively, as shown in Fig. 3, a "chin" type inlet 44 could be defined in the engine core compartment 23 to direct air from the by-pass passage 18 into the secondary gas turbine engine 31.

The secondary gas turbine engine 31 could also be provided with a radial inlet 46 for receiving air from the engine core compartment 23 instead of from the by-pass passage 18, as shown in Fig. 4.

Finally, a hollow inlet strut 48 could extend across the by-pass passage 18 and through the nacelle cowl 12 to allow

ambient air to be drawn radially into the secondary gas turbine engine 31, as shown in Fig. 5.

As shown in Fig. 4, the expanded gases leaving the secondary gas turbine engine 31 could be directed into the main engine exhaust instead of into the by-pass passage 18.

Finally, the expanded gases leaving the secondary gas turbine engine 31 could be directed overboard to the ambient air via a hollow outlet strut 50 extending across the by-pass passage 18 and through the nacelle cowl 12.

It is noted that the inlet and exhausts configurations are interchangeable.

Fig. 6 illustrates a further embodiment of the present invention, which only differs from the one illustrated in Fig. 1, by the location of the secondary power unit 30. Indeed, instead of being integrated in the engine core compartment 23', the secondary power unit 30' is mounted within the main engine aft center-body. According to this arrangement, the by-pass passage 18' constitutes the air inlet source for the secondary power unit 30'. During ground operation, the inlet air is drawn through the stationary fan and the exhaust nozzle 13' of the primary gas turbine engine, then through the by-pass passage 18 and a nacelle inlet 52 connected in fluid flow communication with turbine exhaust struts 54 and finally into the secondary gas turbine engine 31' of the secondary power unit 30'. In

flight, the air flowing to the secondary gas turbine engine 31' has already been compressed by the main engine fan and as a result the performances of the secondary gas turbine engine 31' are improved.

It is noted that the present integration concept applies to either long (Long Duct Mixed Flow) or short cowl (Short Duct Separate Flow) nacelle configurations and is thus not limited to the particular type of nacelle cowl illustrated in the drawings.